

What is claimed is:

- 1 1. A spark plug for an internal combustion engine, comprising:
2 a metal outer shell having a central bore;
3 an insulator secured within said central bore of said shell;
4 a center electrode mounted in said insulator;
5 a ground electrode extending from said outer shell adjacent said central
6 electrode and defining a spark gap therebetween said ground electrode having a
7 through hole located at said spark gap; and
8 a firing tip having a longitudinal axis, said firing tip being received at least
9 in part in said through hole with said longitudinal axis extending towards said
10 center electrode, and wherein said firing tip has a bulging portion extending
11 radially outwardly from said longitudinal axis and mechanically retaining said
12 firing tip within said through hole.

- 1 2. The spark plug of claim 1, wherein said firing tip is compressed
2 axially along said longitudinal axis and said firing tip has a first length prior to
3 being compressed and a second length after being compressed, wherein said second
4 length is shorter than said first length.

- 1 3. The spark plug of claim 1, further comprising one or more weld
2 joints between said ground electrode and said firing tip.

- 1 4. The spark plug of claim 3, wherein at least one of said one or more
2 weld joints is a resistance weld joint.

- 1 5. The spark plug of claim 3, wherein at least one of said one or more
2 weld joints is a laser weld joint.

1 6. The spark plug of claim 1, wherein said firing tip has a pair of
2 generally opposed ends with at least one of said ends having an enlarged head
3 abutting a surface of said ground electrode.

1 7. The spark plug of claim 6, wherein the other of said ends of said
2 firing tip is generally flush with a surface of said ground electrode.

1 8. The spark plug of claim 6, wherein the other of said ends of said
2 firing tip is flared radially outwardly from said longitudinal axis upon compressing
3 said firing tip to define a flared portion of said firing tip.

1 9. The spark plug of claim 8, wherein said through hole includes a
2 counterbore at one end, and wherein said flared portion engages said counterbore
3 of said through hole.

1 10. The spark plug of claim 6, wherein said generally opposed ends of
2 said firing tip both have enlarged heads abutting one or more outer surfaces of said
3 ground electrode.

1 11. A ground electrode for a spark plug, comprising:
2 a wire of a predetermined length having one end attached to a housing of
3 the spark plug and having a second, free end, said wire having a through hole
4 extending through said wire adjacent said free end; and

5 a firing tip having a longitudinal axis with said firing tip received at least in
6 part in said through hole, wherein said firing tip has a bulging portion extending
7 radially outwardly from said longitudinal axis mechanically retaining said firing tip
8 within said through hole.

1 12. The ground electrode of claim 11, wherein said firing tip is
2 compressed axially along said longitudinal axis and said firing tip has a first length

3 prior to being compressed and a second length after being compressed wherein said
4 second length is shorter than said first length.

1 13. The ground electrode of claim 11, further comprising at least one
2 weld joint between said ground electrode and said firing tip.

1 14. The ground electrode of claim 11, wherein said firing tip has a pair
2 of generally opposed ends with at least one of said ends having an enlarged head
3 abutting a surface of said ground electrode.

1 15. The spark plug of claim 14, wherein one of said ends of said firing
2 tip is generally flush with a surface of said ground electrode.

1 16. The spark plug of claim 14, wherein the other of said ends of said
2 firing tip is flared radially outwardly from said longitudinal axis upon compressing
3 said firing tip to define a flared portion of said firing tip.

1 17. The spark plug of claim 16, wherein said through hole includes a
2 counterbore at one end, and wherein said flared portion engages said counterbore
3 of said through hole.

1 18. The spark plug of claim 14, wherein said generally opposed ends of
2 said firing tip both have enlarged heads abutting one or more outer surfaces of said
3 ground electrode.

1 19. A method of constructing a ground electrode for a spark plug,
2 comprising the steps of:

3 providing a segment of metal wire;
4 forming a through hole in the wire;
5 providing a firing tip having a longitudinal axis;
6 inserting the firing tip within the through hole; and

7 compressing the firing tip in the direction of its longitudinal axis such that a
8 first end of the firing tip flares outwardly from the longitudinal axis.

1 20. The method of claim 19, including forming an enlarged head on a
2 second end of the firing tip wherein the enlarged head abuts an outer surface of the
3 wire upon inserting the firing tip within the through hole.

1 21. The method of claim 19, further comprising forming a weld joint
2 between the firing tip and the material.

1 22. The method of claim 21, wherein resistance welding is performed to
2 construct the weld joint.

1 23. The method of claim 21, wherein laser welding is performed to
2 construct the weld joint.

1 24. The method of claim 19, further comprising forming a counterbore
2 extending from at least one of the surfaces into the metal wire and wherein said
3 compressing step further comprises compressing the firing tip to cause the first end
4 to flare outwardly into the counterbore.

1 25. A method of making a spark plug, comprising the steps of:
2 installing a center electrode assembly within an insulator;
3 providing a metal shell having a central bore sized to receive said insulator;
4 forming a ground electrode having a through hole adjacent one end thereof;
5 inserting a firing tip having a longitudinal axis into said through hole;
6 compressing said firing tip in the direction of said longitudinal axis until
7 said firing tip undergoes deformation;
8 attaching said ground electrode to said metal shell; and
9 securing said insulator and center electrode assembly within said central
10 bore of said metal shell.

1 26. The method of claim 25, wherein said forming step further
2 comprises forming said ground electrode such that said through hole has a
3 counterbore at a surface of the ground electrode.

1 27. The method of claim 26, wherein said compressing step further
2 comprises compressing said firing tip such that it flares out into said counterbore.

1 28. The method of claim 27, wherein said inserting step further comprises
2 inserting a firing tip having an enlarged head until said head engages an outer
3 surface of said ground electrode opposite said counterbore.

1 29. The method of claim 25, wherein said compressing step further
2 comprises compressing said firing tip such that it bulges outwardly within said
3 through hole and deforms a center portion of said through hole outwardly, whereby
4 said firing tip is mechanically interlocked to said ground electrode.

1 30. The method of claim 25, further comprising the step of welding said
2 firing tip to said ground electrode.

1 31. The method of claim 25, wherein said providing step is carried out
2 prior to said installing step.

1 32. A spark plug, comprising:
2 a metal shell having a central bore;
3 an insulator secured to said shell within said central bore;
4 a center electrode assembly extending through said insulator and
5 terminating at a firing end;
6 a ground electrode attached to said shell and having a free end located
7 adjacent said firing end, said ground electrode having a through hole located
8 adjacent said free end; and

9 a firing tip extending from a first end to a second end and having an
10 enlarged head at said first end;

11 wherein said firing tip is disposed within said through hole with said
12 enlarged head engaging an outer surface of said ground electrode, said enlarged
13 head being located opposite said firing end of said center electrode assembly to
14 thereby define a spark gap between said enlarged head and said firing end, said
15 firing tip having an expanded portion at said second end that engages an outer
16 surface of said ground electrode such that said firing tip is mechanically
17 interlocked to said ground electrode by said first and second ends.

1 33. The spark plug of claim 32, wherein engagement of said enlarged head
2 and said expanded section with said ground electrode forms a first mechanical
3 interlock of said firing tip on said ground electrode, and wherein said firing tip has
4 a bulging portion that extends radially outwardly within said through hole and
5 provides a second mechanical interlock of said firing tip to said ground electrode.

1 34. The spark plug of claim 32, wherein said through hole includes a
2 counterbore at said second end of said firing tip that defines an inclined outer
3 surface of said ground electrode, and wherein said expanded portion of said firing
4 tip comprises a flared portion that extends into said counterbore and engages said
5 inclined outer surface.

1 35. The spark plug of claim 32, wherein said expanded portion of said
2 firing tip comprises a second enlarged head.

1 36. The spark plug of claim 32, wherein said firing tip is welded to said
2 ground electrode.